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Electrical properties and polarization switching in polycrystalline $BiFeO_3$ thin films

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The multiferroic bismuth ferrite ($BiFeO_3$) has been considered as a potential material for the development of the next generation of technological devices due to its high Curie temperature and superior ferroelectric properties with a giant remanent polarization. However, the practical applications of the $BiFeO_3$ thin films are still limited due to their large leakage current at room temperature. Studies on the physical properties at nanoscale and the search for alternatives that allow the development of new technological devices based on this system have motivated recent research. In the present work, we report studies on the electrical properties and polarization switching in polycrystalline $BiFeO_3$ thin films prepared by chemical solution route and crystallized in air and O_2 atmosphere under pressure at 600°C for 30 min. The piezoresponse force microscopy technique was used to study the polarization switching in $BiFeO_3$ thin films under different voltages. The observed domain sizes were smaller than 200 nm and showed a significant anisotropy of the spontaneous polarization orientation in the grains. Smooth movement of domain walls is observed for weak electric fields, while jumping motion is observed for larger fields. These results will be discussed in terms of pinning of the domain walls and possible macroscopic defects. Electrical properties were studied in terms of *ac* conductivity and complex electric modulus characterized through real (ε') and imaginary (ε'') dielectric permittivity measurements. The frequency (100 Hz to 1 MHz) and electric field effects (0 to 84 kV/cm) on the dielectric relaxation and electric conductivity were reported in the temperature range $300 \leq T \leq 480\,K$. The dependence of the *ac* and *dc* electric field shows a dielectric relaxation like observed as a function of temperature, but fundamentally different from the thermally activated process. Intrinsic defects and interfacial polarization are probable responsible by dielectric relaxation and conduction mechanisms in the studied films.